Addressing Habitat Issues with Remote Sensing in the National Estuarine Research Reserve System

Needs Assessment Final Report

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Prepared by NOAA's Estuarine Reserves Division and NOAA Coastal Services Center

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EXECUTIVE SUMMARY

In the summer of 2002, the National Oceanic and Atmospheric Administration (NOAA) Estuarine Reserves Division and Coastal Services Center conducted a remote sensing and geographic information system (GIS) needs assessment of the reserve system to identify the common issues, capacity needs, and data used in the system. The information was collected through hour-long conference calls with staff at each reserve and the needs assessment team. Prior to the calls, reserves were asked to identify three priority issues within their respective reserves that they felt could be addressed with remote sensing and GIS.

Priority Issues
The needs assessment collected information on three priority issues that could be addressed with remote sensing and GIS. These issues were generally categorized as data, analysis, or management needs, but sometimes fell into several categories or none at all.

The most common data need was upland land cover, followed by information on benthic or subtidal habitats. Topographic and bathymetric data, as well as information on water quality issues such as turbidity, were also common needs throughout the reserves. The analysis category contained issues that required ancillary data collection. A common need expressed was the need for measuring change for different land uses or covers that could be used to examine historical changes, monitor erosion, or assess impacts on managed areas. The management category was the most diverse of the three. It included common issues such as restoration, acquisition, policy and planning, and education and research. There are a number of management issues that could be informed by using remote sensing and GIS data, including permitting for docks, controlling storm water runoff, conducting risk assessments, and deciding where to focus restoration efforts.

Other Results
Many reserves recognize the value of remote sensing and GIS; however, most of them are limited in their capacity to go beyond their current uses and need additional staff and training. Many reserves lack a dedicated GIS staff person, but some have developed partnerships to fulfill their needs. The reserve system is a diverse collection of sites with few having the capacity to conduct in-depth analysis of spatial data. Many of the reserves have access to a variety of data sources (e.g., state data clearing houses) but often find that those sources are not high-resolution.

Results Overview
The assessment identified several common themes among the reserves. First, several reserves do use remote sensing and GIS, but they limit their use to certain activities, such as creating maps of different data layers. They could expand their use of these technologies to various other projects, especially spatial analysis. Second, most reserves do not have sufficient personnel. They need additional staff or training to fully utilize GIS and remote sensing capabilities. Finally, each reserve's expanded use of remote sensing and GIS could benefit the entire system as reserves apply specific uses to larger, system-wide projects and programs.

ACRONYMS

ADAR	Airborne Data Acquisition and Registration
AVHRR	Advanced Very High Resolution Radiometer
BASINS	Better Assessment Science Integrating Point and Nonpoint Sources
BLM	Bureau of Land Management
BMP	best management practices
CICEET	The Cooperative Institute for Coastal and Estuarine Environmental Technology
CZM	Coastal Zone Management
DEP	Department of Environmental Protection
DMR	Department of Marine Resources
DNR	Department of Natural Resources
DOQQ	Digital Orthophoto Quarter-Quad
DOT	Department of Transportation
EIS	environmental impact statement
EPA	Environmental Protection Agency
ESI	Environmental Sensitivity Index
FWS	Fish and Wildlife Service
GIS	Geographic Information Systems
GRF	graduate research fellow
HAB	harmful algal bloom
IR	infrared
LIDAR	Light Detection And Ranging
MPA	Marine Protected Area
NEP	National Estuarine Program (EPA)
NGO	non-governmental organization
NWS	National Weather Service
OCRM	Office of Ocean and Coastal Resource Management
ORR	Office of Response and Restoration
RC	research coordinator
RS	remote sensing
SAV	submerged aquatic vegetation
SeaWiFS	Sea-viewing Wide Field-of-view Sensor
SPOT	Systeme Pour l'Observation de la Terre
SST	sea surface temperature
SWMP	System-Wide Monitoring Program
TMDL	total maximum daily loads (CBV)
TNC	The Nature Conservancy
USGS	United States Geological Survey

INTRODUCTION

A key to conserving coastal ecosystems and restoring estuarine habitats is having information on how human activities and natural events can change ecosystems. The National Estuarine Research Reserve System (NERRS) has established a System-Wide Monitoring Program (SWMP) that tracks short-term variability and long-term changes in coastal ecosystems represented in the reserve system. The monitoring program consists of three phases: (1) abiotic factors including water and meteorological monitoring, (2) biotic factors, and (3) land use/habitat change. Currently, all 25 reserves are participating in the abiotic phase by monitoring a suite of water quality and atmospheric variables over a range of space (local, regional, national) and time (minutes, hours, days, months, years). Additionally, the reserve system is examining ways of implementing the biotic and land use/habitat change phases.

The third element of the monitoring program focuses on land use and habitat change and begins to examine the link between land use activities and coastal habitat quality. Initially, the reserve system considered implementing this phase by improving capacity at the reserves, purchasing imagery (e.g., Ikonos), and developing protocols for future and retrospective change analysis. However, due to questions related to scale, benefits at the reserve level, and the current needs of reserves, the full effort was not implemented. Instead, the reserve system decided upon funding and training for geographic information system (GIS) staff, testing habitat classification schemes, and conducting a needs assessment on remote sensing and GIS technologies.

The National Oceanic and Atmospheric Administration (NOAA) Estuarine Reserves Division (ERD) and Coastal Services Center (Center) designed and conducted a needs assessment to document common reserve issues suited for remote sensing approaches. The needs assessment focused on three primary questions:

- Priority issues: What priority habitat issues might be effectively addressed using remote sensing technologies?
- Capacity needs: Where are the gaps between existing and desired capacity to do habitat mapping and change analysis (e.g., software, hardware, personnel, training)?
- Existing data: What remotely sensed data and GIS imagery are currently available to reserves?

The results of this assessment will help guide future decisions and activities concerning land use/habitat change for the reserve system. Specifically, these results will help in refining the proof-of-concept project funded by ERD and the Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET).

METHODS

The goal of the needs assessment was to identify the gaps between existing and necessary skills, data, and capacity to use remote sensing to address priority issues within the reserve system. Over a period of three months, the needs assessment team conducted hour-long conference calls with staff members at each of the reserves. Participants specified three priority issues within their reserve that they felt could be addressed with remote sensing. These issues were examined in detail during the call. Also addressed were current activities using remotely sensed data, available data, data and capacity needs, and bottlenecks to implementing remote sensing projects within the reserve. A summary of each call was compiled and sent back to participants for review and to invite additional comments. Those participating in the calls included reserve managers, research coordinators, stewardship coordinators, GIS specialists, education coordinators, and local partners.

The initial results of the needs assessment were presented during a meeting at the NOAA Coastal Services Center on August 15, 2002. Participants from NERRS reviewed initial findings and discussed strategies for addressing identified priorities via remote sensing.

Outline of Report

The first section of the report outlines cross-cutting ideas and needs common to many, if not all, of the reserves. The second section discusses the priority issues identified by the reserves. These issues are organized into three broad categories: data, analysis, and management. The final section covers the current capacity and data holdings of the reserve system, as well as stated needs in these areas. For information on reserve-specific responses to the needs assessment questions, see Appendix B, which includes notes from each of the conference calls.

CROSS-CUTTING THEMES

- GIS/RS is used to create maps but not for spatial analysis:

Most if not all of the reserves are currently using GIS/RS in some format in their current activities. However, these projects are often for visualization using basic data layers, rather than spatial analyses. For example, many reserves use GIS/RS to map research and restoration sites, but few are performing change analyses to identify new restoration sites. Reasons for this include lack of trained and dedicated staff to carry out more in-depth projects. Aerial photography is the primary source of remotely sensed data, though several of the reserves have satellite and other remotely sensed data.

- Key need is increased capacity:

Most reserves cannot allocate current staff resources to conduct advanced analysis, but rather need new, dedicated staff to bring in these skill sets. In general, there is not a pressing need for data (many sites do not have time or staff to analyze the data they already have). However, a few reserves are doing more advanced GIS/RS work and would benefit from specific types of data (e.g., high-resolution imagery).

- GIS/RS applications cut across management, research, and stewardship/outreach:

Both existing applications and priority issues identified by reserves highlight the cross-cutting uses of GIS/RS. For example, management purposes include locating priority acquisition projects, research purposes include studying invasive species expansion, and stewardship/outreach efforts include educating people on the connections between land use and resource condition.

- GIS/RS work needs to be recognized as and treated as an ongoing initiative:

Reserves have embraced GIS and recognize that it can be used more extensively for analysis. To maximize its potential, RS/GIS must become a long-term, intrinsic part of the operation of the reserves, and it must be consistently funded.

- Reserves have specified terrestrial *and* benthic information needs:

Reserves need both terrestrial and benthic data to address many of their priority issues. Ideally, reserves want to make the connection between terrestrial changes and aquatic resource health. There is a need to develop tools to study shallow water benthic habitats.

- Habitat analysis is needed at the individual reserve level as well as at the national level:

Additional discussion may be needed to determine what scale RS projects will focus on. Many reserves expressed concern that a system-wide RS/GIS project might not address their individual concerns.

PRIORITY ISSUES

Each reserve was asked to identify three priority issues that could be addressed using remote sensing. Answers to this question ranged from simple data needs (e.g., bathymetric maps of the estuary) to complex management issues requiring a variety of data sources and analysis (e.g., restoration and the effects of management policies). Table 1 in Appendix A summarizes the priority issues for each reserve. Based partly on feedback received at the August 15 meeting, the responses were categorized into data, analysis, and management needs. Within each of these categories, the responses were further divided into several subcategories as follows:

Data

- Land cover (uplands, benthic)
- Invasive species (via land cover)
- Bathymetry and topography
- Water quality (e.g., chlorophyll, turbidity, sea surface temperature)

Analysis

- Land use
- Water quality
- Change detection
- Erosion

Management

- Acquisition
- Assessment of management strategies
- Restoration
- Policy and planning
- Education and research

For a breakdown of the number of responses in each category, see Figures 1 to 3 in Appendix A. Some priority issues comprised more than one subcategory; these were all included in the final counts. Issues identified by reserves often fell into two or more of the broad categories. For example, invasive species were discussed as both a data need and a management issue. Therefore, each of the reserves' three stated priority issues may have been counted several times or not at all within each subcategory. The totals are simply an indication of the relative importance of the various categories to the reserve system. The needs assessment team did not interpret the responses given. Although certain data types are required to contribute to particular analysis or management applications, if the need for these data was not explicitly stated, it was not included under the data section. Table 2 in Appendix A shows how the priorities for each of the reserves were categorized. There were also outlying needs, expressed by only one or two reserves, that did not fit into any of the categories. These needs were categorized as "other" and are listed below Table 2.

For the purposes of this report, the breakdown between data, analysis, and management provides a useful tool for discussion and allows for comparison of similar priority issues across reserves. However, there are several other ways responses could be organized. For example, issues could be separated by their applicability to the five areas of focus within the reserve system: research, education, management, stewardship, and coastal training.

Another useful way of looking at the data is to ask whether they are related to biological, chemical, or physical processes.

The following sections discuss specific needs identified within each of the three broad categories.

DATA

Land Cover (benthic and upland mapping)

Most of the data needs fell under the land cover category, defined as the physical and biological cover of the Earth's surface, including, for these purposes, submerged areas. Although different methods and data sources are required to create land cover for upland and submerged areas, both sets of data can be used to address similar issues. Some reserves specified a need for only benthic or upland mapping, but many require both. Therefore, all types of land cover were combined into one category. Land cover is a necessary first data layer for several analysis priorities, including land use and habitat maps. Some of the reserves stated their priority for the data layer only, while others requested it in conjunction with analysis or management needs. Some of the priority issues that can be addressed with land cover data are as follows:

- Mapping and classifying habitats,
- Prioritizing areas for land acquisition and restoration,
- Informing public policy and the permitting process,
- Investigating the effects of restoration efforts on impacted habitats,
- Educating public officials, schoolchildren, and private citizens,
- Establishing setback lines,
- Monitoring the changing landscape, including increases in development and impervious surfaces, and the effects these may have on water quality and habitats,
- Developing management plans (fisheries, erosion control, etc.) and assessing their effectiveness,
- Quantifying habitat loss or change and corresponding effects on an ecosystem,
- Monitoring the effects of various factors such as fire and storm damage, sea level rise, freshwater input, timber harvesting, sedimentation, and agricultural practices,
- Examining seasonal and inter-annual change, and
- Assessing the degree of fragmentation of the landscape.

Invasive Species (via land cover)

Many reserves mentioned using land cover data for monitoring invasive species. These data can be used in mapping the initial extent of the species, monitoring the change in coverage over time, and assessing the effectiveness of management strategies (such as controlled burns). Part of the challenge in using remote sensing for invasive species management is determining the appropriate data source, since it may be difficult to distinguish invasive species from surrounding vegetation.

Bathymetry and Topography
Six reserves requested bathymetry and/or topography data sets. Most mentioned Light Detection and Ranging (LIDAR) as an appropriate source of these data. The following were mentioned as priorities that could be addressed with the data:

- Determining suitable, potential, or actual habitats (e.g., horseshoe crabs, submerged aquatic vegetation (SAV), oysters) for management of species,
- Modeling of erosion and hydrodynamic processes,
- Establishing setback lines and responding to legal challenges,
- Restoring wetlands,
- Delineating habitats,
- Monitoring effects of sediment runoff management,
- Researching elevation and effects of changing sea levels on salt marsh communities, and
- Performing risk assessment – predicting storm surge effects.

Water Quality Parameters
Many reserves specified water quality as an important priority, although only a couple of them explicitly stated the need to measure particular parameters such as chlorophyll levels, sea surface temperature (SST), turbidity, and nutrients. These parameters are elements in overall water quality, and as such, may be important to monitor. Current satellite-based remote sensing technologies are not well suited to fine-scale coastal quantification of water quality variables. They tend to have low spatial resolution, and nearshore sediments, organics, and bottom reflection can interfere with the accuracy of the data. However, research into newer satellite- and aircraft-based techniques continues in this area. Data on water quality can assist reserves with the following priority issues:

- Assessing the impact of water quality on SAV restoration,
- Correlating water quality to the presence of harmful algal blooms, and
- Influencing policy and permitting decisions.

ANALYSIS

The analysis category contains priority issues that require more than simple acquisition of remotely sensed data. Ancillary data such as field research, impervious surface coefficients, or change detection need to be combined with the raw data to create layers more useful to managers. Many of the bins within analysis have a certain degree of overlap. For example, land use is an integral component of water quality, and change can be investigated in any of these areas.

Land Use
Land use maps are derived from land cover and contain not only physical and biological cover, but also information on how the land is used. For example, the land **cover** category of low intensity development might be further classified into residential or commercial **use**. The creation of land use maps requires ancillary data beyond the remotely sensed image. Land use layers may be of use in the following applications:

- Determining historical changes and patterns of development,
- Estimating population growth,

- Determining the effects of land use on habitats and water quality (e.g., agricultural practices),
- Assessing potential impacts of hazards and developing management strategies to deal with them,
- Assessing natural resource management strategies, and
- Educating coastal decision makers and influencing regulatory policies.

Water Quality

Water quality issues are closely tied to land use and land cover. High levels of impervious surfaces (a variable which can be quantified with land cover or land use maps) are correlated with decreases in water quality. Other data sources can also contribute to an understanding of water quality, such as the measurement of turbidity, phytoplankton, and nutrient levels. Water quality data can assist reserves with the following priority issues:

- Assessing environmental impacts of practices such as silviculture, agriculture, restoration of SAV beds, etc.,
- Determining the health of the ecosystem,
- Educating local and state officials, and the public,
- Policy making and planning (e.g., as a tool for storm water runoff planning),
- Predicting the success of habitat restoration,
- Monitoring the effects of development, and
- Modeling nitrogen inputs and their effects,

Change Detection

Change analysis starts with a baseline data layer and compares it to a later or earlier data layer of the same location. Change can be measured for any data layer, and was mentioned by reserves most often in conjunction with other analysis categories, such as land use, erosion, or water quality. These analyses are very useful for investigating dynamic landscape processes, such as the spread of development. They can be used to address the following:

- Measuring seasonal or interannual changes in sediments, cropland, development, etc.,
- Monitoring the effects of management strategies,
- Investigating historical changes in ecology, population distribution, habitat,
- Modeling changes in the watershed (e.g., impervious surfaces, runoff) and potential effects on water quality and sensitive habitats,
- Assessing human impacts on managed areas (e.g., prop scarring in SAV beds),
- Prioritizing restoration efforts,
- Educating public and local officials on habitat change,
- Providing evidence for permitting and regulatory decisions,
- Investigating the effects of environmental changes (increased freshwater, sea level rise, storms, sedimentation, etc.) on habitats, and
- Monitoring erosion processes.

Erosion

Erosion analysis is based on shoreline change or in the topography of an area. Base data layers include any type of imagery in which the shoreline can be detected or topography data from LIDAR or other sensors. Erosion analyses can aid in the following priority issues:

- Monitoring the effects of coastal structures on the shoreline,
- Assessing the effectiveness of erosion mitigation strategies,
- Educating landowners about building too close to the shore,
- Informing policy makers,
- Establishing setback lines,
- Assessing the effects of hurricanes, and
- Determining appropriate placement for dredge material.

MANAGEMENT

The management category is the most diverse of the three. Several basic management functions were common to many of the reserves, but for the most part, these activities are applied in various ways to reserve-specific projects. Therefore, the lists within each category are quite mixed. Some priorities expressed by only a few reserves included assessing the effects of setbacks, riparian zones, livestock management, harvesting, and sedimentation/runoff management. More information on the range of responses can be found in Appendix B, the individual call summaries.

Acquisition

Reserves have many different ways of prioritizing land for acquisition, but most use some form of aerial imagery, with parcels and other data overlaid, to determine ownership and the location of sensitive areas. Imagery can also show where development pressures will be strongest and where it might be important to establish buffer zones.

Restoration

Imagery, and especially change detection, can be used to assess areas in need of restoration or to monitor the effects of restoration strategies. Areas of high fragmentation and habitat loss can be identified. Remote sensing data can be of help in the following:

- Comparing strategies for dune rehabilitation,
- Deciding where to focus restoration efforts, and
- Assessing effects of management decisions on habitat and land cover.

Policy and Planning
One way of effecting change at the larger watershed level is to influence the policy-making process. With remotely sensed data and analysis of these data, managers can educate planners and officials in the issues facing their environment. Reserves mentioned several policy and planning issues that could be informed by this type of information:

- Permits for docks and coastal structures,
- Policies for use of habitats such as SAV beds,
- Permits for use of water resources,
- Storm water runoff plans,
- Risk assessment and planning for hazards,
- Permits for land use, agricultural practices, fisheries, etc., and
- Development planning.

Education and Research
Most of the data and analysis bins have applications for research, education, or both. A short list follows, but again, more information can be found in Appendix B, the individual call summaries.

- Research site identification,
- Education on the effects of agricultural practices on water quality,
- Education of municipal officials on local issues,
- Education of property owners on erosion and beach issues, and
- Outreach programs to teach best management practices.

CURRENT CAPACITY

For the most part, reserves have access to more data layers than they actually use. There are a number of sources for these data, including state data clearinghouses, various individual state departments (transportation, environment, natural resources, etc.), local county offices, nonprofit groups such as The Nature Conservancy, colleges and universities, individual researchers, the National Aeronautics and Space Administration (NASA), and NOAA. Unfortunately, these sources often have data at lower spatial resolution (e.g., Thematic Mapper 30 meter pixel satellite imagery) than is necessary for reserve projects. The most requested data sets are benthic data and higher resolution imagery (e.g., IKONOS 4 meter imagery). A number of reserves have also expressed a need for remote sensing software to do more analysis on the imagery.

Some reserves have developed advanced tools for use in data acquisition and analyses; for more detailed information, refer to the existing applications section of the individual call summaries in Appendix B.

A key bottleneck across the reserves is staff time and training. Most reserves do not have a full-time GIS technician. Several sites have a dedicated part-time staff member to fill this role, others send GIS projects to parent agencies or partners, and several rely on staff members such as the research coordinator to address the GIS tasks. While most reserves have at least one staff member who has received basic GIS training, few have staff members trained in remote sensing and image analysis. There is a need for more funding for GIS and RS staff, as well as for training for existing staff. Some suggestions heard during the calls included sharing staff with other organizations, and establishing a central GIS "Help desk." For a summary of the data and capacity needs of the reserves, see Tables 3 and 4 in Appendix A.

APPENDIX A - Tables and figures

Table 1. Priority issues for each reserve

Reserve	Priority Issues		
ACE	Land Acqusition	Habitat fragmentation and restoration	Invasive species
APA	Island erosion/accretion, strategies for dune rehab	SAV mapping	Habitat mapping - upland and marsh. Impacts of silviculture, restoration
CBM	Land use change	Change in vegetation, correlation to water quality	Bathymetry
CBV	Water quality and SAV restoration	Mapping shallow water emergent habitats	Upland vegetation and change
DEL	Invasive species	Shoreline erosion/Topography	Development - habitat loss, impervious surface
ELK	Habitat mapping for acquisition and restoration	Habitat change mapping and monitoring - priority aquatic and adjoining upland	Short term research studies using GIS - sediment fans, land use/water qual, invasives
GNB	Land cover and change – habitat mapping - uplands and submerged	Invasive species	Coastal erosion
GRT	Saltmarsh area change – habitat mapping, invasives, update NWI	Impervious surface	Habitat fragmentation, acquisition and restoration
GTM	Landuse and change detection; water quality	Determine BAT to map estuarine habitats	Monitoring estuarine dynamics - SST, sediments, phytoplankton
HUD	Functions of aquatic habitats	Develop shallow water survey techniques	Benthic community mapping and change. Human impacts
JAQ	Benthic habitat mapping	Land use/land change - impervious surface, development, etc.	Saltwater marsh habitat, change in structure, function
JOB	Land use and resource health in entire watershed	Runoff and water quality (imp. surf)	Land use and groundwater demand
KAC	Saltmarsh plant classification and elevation	Benthic habitat mapping	Freshwater wetland plant classification
NAR	Impervious surface, land use change	Invasive species	Water quality changes
NOC	Habitat maps -esp. subtidal data – for mgt, educ, research	Invasive species	Shoreline deliniation
NIW	Habitat mapping and change - wetlands, uplands, benthic	Shoreline change	Impervious surface mapping and water quality
OWC	Land use change, impervious surfaces	Conservation practices in agriculture	Nearshore and stream aquatic mapping
PDB	Seagrass mapping	Bathymetric and topographic map	Baseline habitat mapping of bay and watershed
RKB	Land use and pollution loading, flow way change	Terrestrial habitat mapping	Subtidal habitat mapping
SAP	Land use/development	Monitor marsh vegetation - sea level change	Assess resource management strategies - burns, harvests, etc.
SOS	Habitat maps - subtidal, intertidal, riparian areaas and uplands	Bathymetric and topographic map	LU/LC and change for entire estuary
TJR	Creation of roads and trails by Border Patrol	Monitor restoration and management sites	Montor effects of sediment loads and management strategies
WQB	Water quality (imp surf)	Coastal structures and change	Habitat mapping - watershed wide
WKS	Land use/impervious surfaces, etc.	Habitat change - benthic and upland	Water quality, imp. surf, erosion/accretion
WEL	Watershed management and restoration	Bathymetric and topographic map	Vegetation cover

Figure 1. NERR data priorities

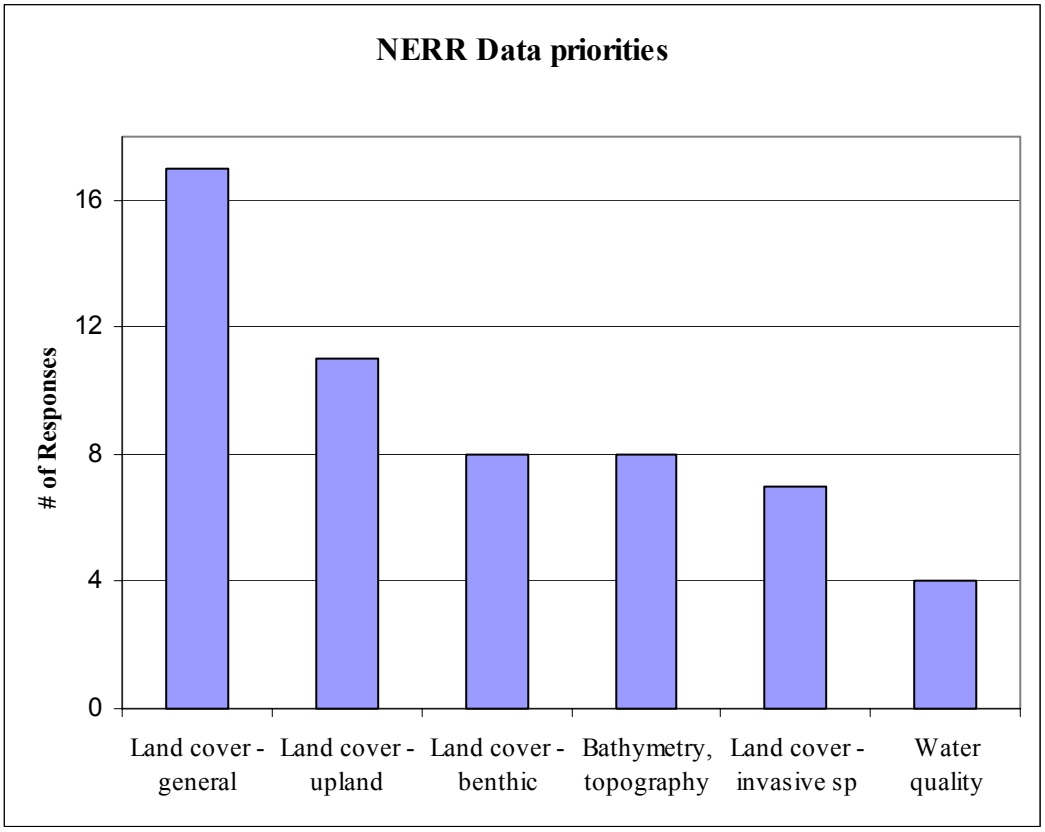

Figure 2. NERR analysis priorities

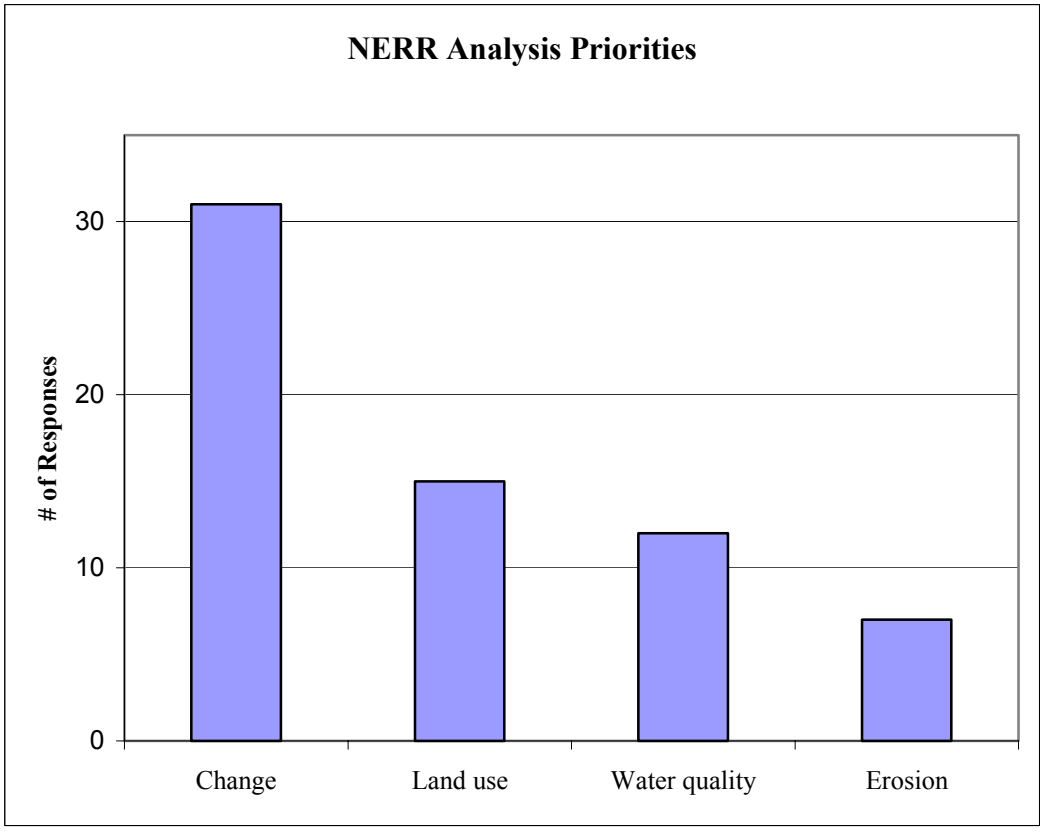

Figure 3. NERR management priorities

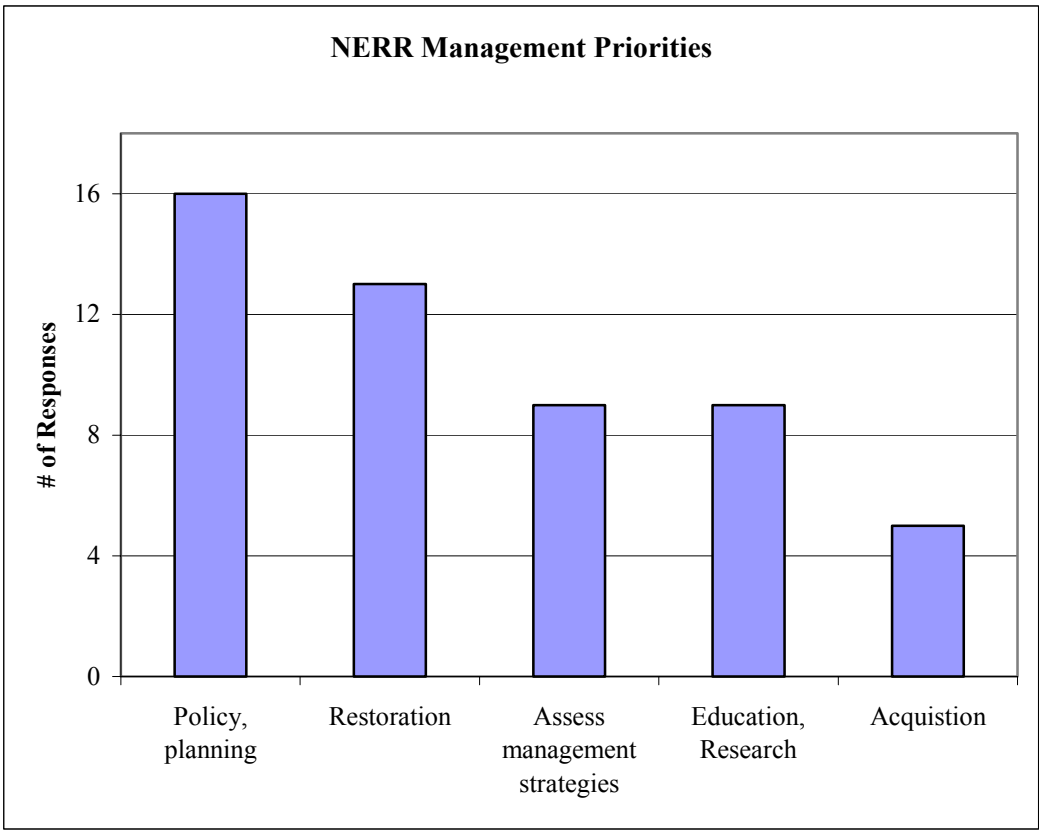

Table 2. NERR priorities by category

Reserve	Data	Analysis	Management
ACE	Land cover - general		Acquisition
		Change	Restoration
	Invasive species		
APA		Erosion	Restoration
	Land cover - benthic	Change	Policy/Planning
	Land cover - upland	Land use and Change	Restoration
CBM	Land cover - upland	Land use and Change	Education/Research and Assess management strategies
	Land cover - benthic	Water quality and Change	Policy/Planning and Education/Research
	Bathymetry/topography	Other	
CBV	Water quality	Water quality	
	Land cover - benthic and Bathymetry/topography	Other	
	Land cover - upland	Change	
DEL	Invasive species	Change	Assess management strategies
	Bathymetry/topography	Erosion	Restoration
	Land cover - upland	Other	
ELK	Land cover - general		Acquisition and Restoration and Assess mgt strategies
	Land cover - general	Land use and Change	
			Education/Research
GNB	Land cover - general	Land use and Change	
	Invasive species		Assess management strategies
		Erosion	Policy/Planning
GRT	Invasive species	Change	Restoration
		Water quality	
			Acquisition and Restoration and Education/Research
GTM	Land cover - general	Land use and Change and Water quality	Education/Research and Policy/Planning
	Other		
	Water quality	Water quality	
HUD		Other	
	Other		
	Land cover - general	Change	Other
JAQ	Land cover - benthic		
		Land use and Change	
	Land cover - upland		Restoration
JOB	Land cover - general	Land use and Change	
	Other	Water quality	
	Other	Other	Policy/Planning

Table 2. NERR priorities by category, continued

KAC	Land cover - upland and Bathymetry/topography		
	Land cover - benthic	Other	
	Land cover - upland	Other	
NAR		Land use and Change	Policy/Planning
	Invasive species		Assess management strategies
	Water quality	Water quality	
NOC	Land cover - general		Policy/Planning
	Invasive species		
		Erosion	Education/Research
NIW	Land cover - general	Water quality and Change	
		Erosion	Education/Research
		Water quality	Policy/Planning
OWC		Land use and Change	
		Land use	
	Land cover - general		Assess management strategies
PDB	Land cover - benthic	Change	Policy/Planning
	Bathymetry/topography		
	Land cover - general	Change	
RKB		Land use and Change	Acquisition and Restoration and Education/Research and Policy/Planning
	Land cover - upland		Policy/Planning
	Land cover - benthic	Change	Policy/Planning
SAP	Land cover - general	Change and Water quality	Policy/Planning
	Land cover - upland	Change	Policy/Planning
	Land cover - general	Land use	Assess management strategies
SOS	Land cover - general		
	Bathymetry/topography		
	Land cover - general	Land use and Change	
TJR		Change and Other	
		Change	Restoration and Assess management strategies
	Land cover - upland and Bathymetry/topography		Assess management strategies
WQB		Water quality and Change	
		Erosion and Change	Policy/Planning
	Land cover - general		Acquisition and Restoration and Education/Research
WKS		Land use and Change	
	Land cover - general and Invasive species	Change	
	Land cover - benthic and Water quality	Water quality and Erosion	
WEL			Restoration and Policy/Planning
	Bathymetry/topography	Other	
	Land cover - upland	Land use and Change	Restoration

Table 2. NERR priorities, "other" responses by category

Other Data issues

- Technology for benthic land cover
- Runoff
- Groundwater demand

Other Analysis issues

- Potential for SAV colonization
- Impervious surfaces
- Functions of aquatic habitats
- Habitat for fisheries
- Estuarine health
- Linkages between physical habitat and biology
- Development of new roads
- Effects of elevation

Other Management issues

- Human impacts

Table 3. NERR needs and bottlenecks to using remote sensing

Reserve	Data/software needs	Bottlenecks
ACE	Image processing software, 1m resolution imagery/photography	$, Staff time, Image processing software and RS training
APA	Ikonos data, baseline habitat classification	Staff time - need dedicated GIS tech
CBM	Hi-res aerial photography, preferably several during the course of the year - SAV and water qual.	Staff time
CBV	Bathymetry, benthic substrate, water quality	Staff training
DEL	Benthic data, data analysis	Staff time
ELK	High res, high accuracy multispectral imagery	Long term funding for projects, staff
GNB	High res habitat layer (terrestrial and submerged)	Dedicated staff, computer and software
GRT	High res Ikonos data	Staff time, GIS technician
GTM	Submerged habitat data	Money, staff expertise and training
HUD	Shallow water benthic mapping techniques, uses for the benthic data	shallow water techniques, database management, data dissemination
JAQ	Benthic habitat	Benthic habitat maps
JOB	Tools for investigating and montioring habitat degradation	Staff time and training
KAC	benthic/subtidal map, including biological and physical characteristis	Funding for staff
NAR	Parcel data	Staff training in RS
NOC	Benthic data	Not enough staff
NIW	GPS unit, elevation model	More RS training
OWC	High res imagery	Staff time, training
PDB	High res color aerial photog. RS software	Not enough imagery, need RS software
RKB	Software, but not sure what type would be appropriate	Staff training and classification protocol
SAP	Want photo coverages to look at mainland changes. Updated software	Lack of personnel
SOS	1 m aerial photography and LU/LC data sets	Want to build county GIS data, need someone (share?) w/GIS capability
TJR	Fine resolution LIDAR data, preferably several times throughout year	Training and staff time
WQB	Image processing software	Strategies for using RS in management. GIS staff and time
WKS	Image processing software, high temporal resolution, landuse/habitat data sets	Training
WEL	Image processing software, new aerial photography	Time, money, training

Table 4. GIS/RS capacity of the reserves

Reserve	Dedicated GIS staff?	GIS/RS capacity	Partners
ACE	Part time	GIS staffer needs RS training	Many
APA	No	5 people know how to use it, but don't have the time	FWS, USGS - not strong partnerships
CBM	No, but DNR fills all of their GIS needs	Not much analysis. Mapping and photographs provided by DNR	Parks and Rec, Isaac Walton League, DNR
CBV	No	Most spatial analysis done through VIMS	Many
DEL	50% for NERR, but work w/in CZM also	Lots of GIS mapping, not much analysis	Many
ELK	Yes - 1 from NERR, one from Foundation	Creating tools for planners, other analysis	Many - good relationship with UCSC, Mont bay, etc.
GNB	No	Not much in house - can do some at DMR (parent agency)	Many
GRT	No	Not much in house - contracted out to Complex Systems @ UNH	TNC, UNH, CZM, NEP
GTM	No	Much done by WMD, some mapping also	WMD, DEP, local governments
HUD	Yes	Most spatial analysis done @ Cornell	Cornell is very strong partner, others also
JAQ	Yes	Lots of GIS and RS, work with Rutgers	Rutgers, NJ DEP
JOB	No	Contract out image analysis, have lots of work done at UPR	UPR is strong partner, EPA, CZM, DNR
KAC	50%	Yes, several projects	Many
NAR	RC is currently GIS person on staff	No RS done at reserve, but lots of GIS from state used in projects	URI, state
NOC	No	Not much. Too many other things to do	Not many
NIW	No, but manager and EC do a lot of GIS	Analysis, but not as much project management	Several
OWC	No	Not much on site	state, county, local governments
PDB	80% time - funded by grants mainly	GIS used in projects, not so much RS	GIS users
RKB	Yes - funded by NOAA OPS grant	GIS used, not as much RS analysis	WMD, FWS, Conservancy of SW FL
SAP	Yes, currently 2 part time	Not so much RS use	UGA, CZM program
SOS	No	Not much GIS use other than mapping. Want to farm out RS analysis to others (no time?).	Generally other GIS users, and Indian tribe
TJR	No	None - GIS computer stolen	San Diego State University, UC San Diego
WQB	Currently part time student, will be leaving	Currently OK for GIS, not much RS experience. Will probably contract out	Many
WKS	Yes	Lots of GIS, some RS	Many
WEL	80% time, also 1/2 time person has GIS experience	identify research sites, proposals, mapping, shoreline project	Many

APPENDIX B - Conference Call Summaries

ACE Basin Conference Call notes

Capacity needs/Problem issues:

Training
RS training for GIS lead
GIS training for other staff members

Technology/Data
- Would like image processing software (currently only have Image Analyst for ArcView) – ENVI
- Would like increased storage capacity for data, second computer w/image processing capability
- Would like 1m resolution, to evaluate several different classification schemes. Could share high resolution imagery with OCRM, DNR. Would prefer to have entire watershed for Edisto and Coosaw. Existing aerial photography does not have appropriate bands to identify areas of invasive species. Also, would prefer to have low tide coverage
- Would like parcel data for Colleton County

Broader Management issues
Funding for GIS intern
State budget
Staff time

Priority issues:

Issues specified by NERR pre-call
- Land acquisition of Edisto Island, parts of Beaufort county - Identify areas with priority to protect, add to reserve. Use SWMP model to evaluate the areas, look at habitats, current development.
- Habitat fragmentation/wetland restoration – what has changed? Track loss of forest, added infrastructure.
- Invasive species – limited by the current imagery, lacking necessary band.

Other issues which could be addressed using RS
- Morgan island pilot project for habitat mapping, land acquisition.
- Restoring rice impoundments to natural vegetative state. Using combination of elevation models and imagery
- Oyster reef and benthic habitat mapping
- Causeway has created a reduction in water flow, reduced flow to oyster beds, overgrowth by *Spartina* – use RS to investigate potential for new bridge, document that need, potentially aid in finding funding sources.
- Impervious surface evaluation
- SC Maps – maps for school children
- OCRM dock sitings, permitting

Existing Applications:
- Restoration science – identify forest causeways, before/after. Restore rice impoundments to natural vegetation
- Use RS products and mapping efforts to leverage funding
- Mapping invasive species
- Use to help control development – outreach tool
- Groundtruth National Wetlands Inventory (NWI)

Partnerships

- TNC – fronting funding for property until grants come through, Edisto Open Land Trust
- Beaufort County fund
- State DOT, Edisto beach – potentially work together to look at oyster habitat restoration and causeway problem
- Creating a workshop, with ACE as co-sponsor, on RS applications
- Property owners

Appalachicola Conference Call notes

Capacity needs/Problem issues:

Training/Personnel
Bottleneck: Lack of staff time to do GIS, habitat classification. Need a dedicated GIS person

Technology/Data
- DOQQ's are IR and in a difficult projection. Want true color.
- Aerial photography timing and quality difficulties
- No problem with software/hardware – have Erdas Imagine as well as ArcView, MapInfo, plotter
- Would like Ikonos data
- Want baseline classification, and methodology on updating data

Priority issues:

Issues specified by NERR
- Barrier island erosion/accretion – Cape St. George project. Compare strategies for dune rehabilitation post hurricane – low v. high human activity.
- SAV coverage change – increasing salinity changes distribution and abundance of seagrasses. Could assist in dock permitting, identification of prop scarring. May affect oyster harvests
- Change/loss of upland and marsh habitats – phragmites, fire impacts, storm impact, buildup of sediment. Look at impact of silviculture on the hydrology, water quality. Make recommendations re: land restoration

Issues identified during call
- Prioritize areas for acquisition
- Map oyster bars with aerial photos
- Track land use/land cover changes. Lots of change and development expected to occur soon

Existing Applications:

- Trying to map seagrasses using aerial photography
- Hydrological restoration
- Fire management
- Facilities construction, infrastructure design
- Monitor marsh area, change, species
- ID and prioritize areas for land acquisition

Partnerships

- Some work with FWS, USGS
- TNC and county ask for imagery, data sets
- Get data from Florida Marine Research Institute (FMRI)

Final suggestions/comments/potential solutions

Would prefer to be supplied with classified imagery, a useable data set rather than just imagery

Chesapeake Bay, MD Conference Call notes

Capacity needs/Problem issues:

Training/Personnel
GIS work done by the DNR, working cooperatively with NERR. They don't tend to do a lot of data analysis, rather build maps and create pictures.
Bottleneck: Staff time. Would also like more training for staff, and will probably get this from DNR.

Technology/Data
- Almost no hardware/software at NERR, all through DNR. Otter Creek and Monie Bay have computers with ArcView 3.2.
- Reserves are remote, have a modem interface, hard to get data.
- Would like series of aerial photography to look at rice beds

Broader Management issues
NERR does not do day-to-day management, but rather oversees partners and provides them with necessary information.
There are different issues for each of the three separate reserve sites.
Sites are not driving research or GIS projects.
State of MD is in a fiscal crisis, so travel is not allowed for training.

Priority issues:

Issues specified by NERR
- Determine land and watershed use changes to monitor increasing development and impervious surfaces. Department of Planning does land cover mapping, but not at the resolution that is desired. NERR would like 1:12,000 scale or better land cover, not necessarily using the Anderson scheme. This land cover would be of use in education, to show the connections between the backyard and the reserve; in research, to provide potential PI's with site information; to look at sediment loads and water clarity; and to investigate seasonal changes, interannual changes, and the effects of management strategies.
- Changes in vegetation – look at SAV distribution and potentially correlate with water quality, if flights could be flown more than once per year. Researchers at UC Davis are experimenting with hyperspectral imagery to try to distinguish varieties of SAV. These data could be used for policy-making and outreach.
- Bathymetry data – NERR is currently using USGS quads. Would like to have more detailed bathymetry, especially to look at potential areas for SAV colonization.

Existing Applications:

- ID properties for acquisition using tax maps, wetland habitat maps, etc. Attempt to buffer protected areas from encroaching development.
- Patuxent River area – used aerial photography to demonstrate decline of wild rice beds, linked to Canada goose populations. Need to determine consistent methodology for data collection, determine what types of imagery are best.

Partnerships
- MD National Capital Parks and Planning Commission, Anne Arundel and Hartford County Parks and Recreation
- Hartford chapter of the Isaac Walton League
- Wildlife and Heritage division of the DNR

Chesapeake Bay, VA Conference Call notes

Capacity needs/Problem issues:

Training/Personnel
Bottleneck: People with the right training and time to focus on GIS issues

Technology/Data
- Planning to move to Arc8, will be getting a larger computer system. Have access to Image Analyst, digitizing table, ESRI, Imagine through Virginia Institute of Marine Science (VIMS)
- Would like good bathymetry, benthic substrate map, and aerial measurements of water quality parameters such as turbidity and chlorophyll concentrations
- Want centralized access to all data layers available at CB NERR VA and VIMS

Broader Management issues
There is some capacity in house, mostly at VIMS, where GIS in research has been largely related to SAV, tidal and non-tidal emergent and forested wetlands
Currently no RS in education, outreach, or CTP, mainly just map generation

Priority issues:

Issues specified by NERR
- Would like to use imagery to look at water quality; chlorophyll, nutrients, and turbidity levels, and how these affect SAV restoration. Effects of chlorophyll on low DO levels at depth, TMDL and storm effects. This information would be used to input into a developed BASINS model. This is time dependent, and would ideally entail weekly overflights.
- Mapping shallow water subtidal, intertidal and emergent habitats. Photos taken for SAV coverages aren't at a good time for wetland species, and other types of imagery (especially satellite) are of too coarse a resolution for accurate change analysis. CB NERR VA would also like to look at fisheries habitat, substrate types, slope, bathymetry.
- Emergent wetlands and upland vegetation classification and change. In one freshwater area, brackish water is beginning to move in. This may be due to sea level rise and/or land subsidence, and they would like to document the change, but again existing imagery is not appropriate. This has management implications.

Existing Applications:

- Looking at riparian buffers, to ensure that they are of adequate size to help in denitrification, uptake of nutrients. Using C-CAP land use classification and nutrient budgets to inform a groundwater quality model. Includes soil data.
- Yearly overflights for mapping SAV, classifying into community types, calculating monthly biomass.
- Using aerial photography as evidence to show prop scarring, for use in creating refuges and sanctuaries, set restoration goals and areas, and estimate historic turbidity levels/water quality
- Identify impacts from boat scarring to SAV and benthic areas
- Land use change in York River watershed.
- Land use classification for sediment loading models
- Sidescan sonar on oyster reefs, to look at substrate and compactness of natural vs. artificial reefs. Benthic mapping, coupled with photography and sampling. Investigate the changes in benthic structures and bathymetry, and whether these are naturally caused.
- Surface mapping of water quality constituents using towed arrays of sensors in shallow water areas

- Undulating towed vehicles with sensor arrays to quantify water quality characteristics (especially dissolved oxygen in 3-dimensional space)

Partnerships

- VIMS – Center for Coastal Resources Management, SAV Research and Restoration Group, Shallow Water Processes Research Group, Water Quality Core Program
- USFWS, USEPA Chesapeake Bay Program
- USGS
- Virginia Department's of Game and Inland Fisheries, Conservation and Recreation, and Environmental Quality
- Maryland Department of Natural Resources
- University of Virginia and Virginia Tech

Delaware Conference Call notes

Capacity needs/Problem issues:

Training/Personnel
Bottleneck: Staff time

Technology/Data
- Want ½ or ¼ acre LU/LC for land acquisition, restoration, preservation
- **Need:** benthic data – acoustics, sampling, nearshore bathymetry
- Issue accessing large files, but putting in a new server and have T1 line
- **Need:** analysis and data crunching

Priority issues:

Issues specified by NERR
- Mapping of invasive species – have data of sprayed area, now want to document change. Fly for purple loosestrife when in bloom
- Shoreline erosion, topography – low level photogrammetry to establish setback line. LIDAR too inaccurate for legal purposes. Also look at horseshoe spawning areas. Use in wetlands restoration, hydrodynamic modeling
- Development issues – many houses planned, big issue in upper watershed. Developers required to set aside open areas, so upland cover/habitat info would be good. Also impervious surface work

Existing Applications:

- Mapping of invasive species – Phragmites and purple loosestrife
- Impacts of beach projects, borrow areas
- Some side scan sonar work
- Tracking horseshoe crabs - RoxAnn

Partnerships

- Most of the work is with the CZM office – they use the NERR as a training site for technologies, then use them throughout the state
- University
- TNC, FWS, DNR (Parks and Recreation, Natural Areas)
- State lands office
- EPA

Elkhorn Slough Conference Call notes

Capacity needs/Problem issues:

Training/Personnel
Currently plenty of GIS trained people, but will soon run out of funding
Bottleneck: ongoing effort, long-term funding and dedication to projects

Technology/Data
- Want aerial photography with more bands – esp. NIR
- Have good hardware and software – much of it personal copies (ArcView, Spatial and Image Analyst, TNT Mips). Need more licenses for ArcView
- **Need**: ENVI (or Erdas)
- **Need:** color IR with high spatial resolution (1/2 or 1 m) resolution and accuracy (10m). Maybe multispectral satellite imagery

Priority issues:

Issues specified by NERR
- Habitat mapping: Prioritize areas for acquisition and restoration, determine effects of different management strategies
- Historical Ecology - look at habitat change using historical data. Land use, tidal change, algal mats – using field work and photography
- Use GIS as a research tool – short term, focused studies, ex: sediment fans and ecotones, water quality and land use, invasive species

Existing Applications:

- Habitat mapping to prioritize land acquisition, restoration.
- Mapping exotic species – GPS overlay on imagery
- Using historical aerial photos and Ikonos data to map wetlands and hydrological change
- Educational materials based on habitat analysis
- Developed tool for planners without GIS capacity – integrates aerial imagery, zoning, conservation issues, policies, slope, sensitive habitats, topo map, etc.
- Did a CTP workshop with experts in different habitats in order to determine what needed to be mapped, how to ground truth, etc. Decision maker workshops

Partnerships

- Naval Postgraduate school – provide Ikonos imagery
- Access to University of California at Santa Cruz (UCSC) – hyperspectral aerial photography, image processing lab
- Cal State
- Monterey Bay sanctuary (data sharing)
- Natural Resource Conservation Services – agriculture and erosion
- Moss landing marine lab
- TNC – Elkhorn Slough manages their lands
- County
- Elkhorn Slough foundation

Final suggestions/comments/potential solutions

Decision maker workshops
Planners tool
Share tools/program info between reserves
Focus on reserve-based problems and issues, minimal nationwide effort (maybe just a higher classification scheme)
SC's should be equal partners to the RC's – could encourage more interaction with listserve or overlapping meetings
Don't incorporate habitat mapping within SWMP

Grand Bay Conference Call notes

Capacity needs/Problem issues:

Training/Personnel
Had GIS specialist until recently, in the department – not at the reserve
DMR trains local users in ArcView as part of the Comprenhensive Resource Management Plan
Bottleneck: dedicated GIS/RS staff

Technology/Data
- Would like a detailed (1m) habitat layer (terrestrial and submerged)
- **Bottleneck**: Workstation with software at reserve
- Have ArcView (some use of Arc8), Imagine, Spatial Analyst, Chartview, Modeler at the DMR (parent agency), but no workstation at the reserve

Priority issues:

Issues specified by NERR
- There is a lot of wet pine savannah habitat being lost, so NERR would like to have land cover, land use, and change across reserve. Can you distinguish between longleaf and other pine habitats? Habitat mapping would also be of interest in submerged habitats.
- Invasive species: Several species of invasives are coming in, and being removed by the US Fish and Wildlife Service. Using remote sensing, they could look at the extent of coverage and monitor the removal program.
- Coastal erosion: There is no freshwater influx, so sediment is not being replaced. There were formerly offshore islands, which protected the shoreline, but no longer. The remotely sensed data could be of use in development of renewal plans, restoration, control of erosion, vegetation planting, and placement of dredge material.

Issues identified during call
- Look at the dynamics of submerged habitats (SAV, seagrass beds), how they change over time, their health, and mapping of historic species. This could be of use in restoration.
- Monitoring red tides on the Alabama border. There is potential for working together with AL government.

Existing Applications:

- Preliminary work done for EIS by the Museum of Natural Science – habitat characterization, endangered species, invasives.
- GRF is using aerial photography to map oyster beds

Partnerships

- Museum of Natural Science, MS State Coastal Research, Department of Wildlife
- Long leaf alliance – out of Auburn University
- MS automated resources information system – state agency that holds GIS data layers
- Gulf Coast Research Lab – University of Mississippi College of Marine Science
- MS State University
- The Nature Conservancy
- Jackson State University
- NASA Stennis provides imagery to DMR

Great Bay Conference Call notes

Capacity needs/Problem issues:

Training/Personnel
Fish and Game (parent agency) only just began using GIS
Bottleneck: No in-house capacity – want at least part time GIS tech, figure out applications. Also lack of staff time

Technology/Data
- No working plotter
- No RS software
- Want high resolution Ikonos data, could be used for impervious surfaces and habitat fragmentation
- **Bottlenecks** – office space, hardware

Broader Management issues
Recently purchased lots of land, need to make an individual management plan for each one
Personnel spread out at different sites
Not allowed to hire interns – state bureaucracy

Priority issues:

Issues specified by NERR
- Saltmarsh area change – prioritize areas for restoration, look at invasives. Have not gotten into technicalities of data
- Impervious surface – reserve currently very open (not much impervious surface), want to have baseline data, and look at effects on water quality. City of Portsmouth working on impervious surface using Ikonos imagery – developing methodology with Complex Systems
- Habitat fragmentation – acquisition, restoration, document species and impacts. Want high resolution – Ikonos? Use for education of municipal officials

Existing Applications:

- External researcher, funded by CICEET, looking at groundwater intrusions, sources, sites, nitrogen levels - using color IR

Partnerships

- TNC for acquisitions – methodology of prioritizing based on their data. Include FWS, EPA, environmental groups
- Complex Systems – GIS unit at University of New Hampshire (UNH) – subcontract all GIS work
- National Estuaries Project – doing water quality project
- NH CZM office – work on restoration
- Jackson Lab at UNH – prioritizing restoration

GTM Conference Call notes

Capacity needs/Problem issues:

Training/Personnel
Between GIS technicians currently – will hire someone, whose time will be consumed by supporting GTM mapping needs, and supporting partners - not financially able to hire expert to do complex analysis or processing of new imagery

Technology/Data
- Saint John's River Water Management District (SJR WMD) provides the technical expertise in GIS, and shares many data layers with NERR. However, tends to be on slightly broader scale (12,400 square mile district)
- Have ArcView 3.2, Spatial analyst, ArcPress – get some extensions from WMD. WMD will be moving to Arc8

Broader Management issues
Bottleneck – Money to do GIS work, staffing and staff expertise. State positions with benefits not available, there are other priorities before advanced GIS positions.
Need land use change analysis in plain English report (not spreadsheet of acreage) in order to be useful for education programs and improving management by coastal decision makers.

Priority issues:

Issues specified by NERR
- Historic landuse and change detection. There is plenty of available imagery, would like to generate analysis. Probably will contract out. Would be useful to local governments, coastal decision makers, and the public (outreach and education). Could also have implications for water quality. This combined with habitat information would be of use for fisheries management (shellfish harvesting, shrimping, etc).
- Determine tools to map and classify estuarine habitats. May include monitoring health of communities. Do not yet know what would be the best available technology.
- Monitoring estuarine dynamics – sediments, SST, phytoplankton. Students at University of Florida (UF) monitor phytoplankton and water quality data through SWMP project. HABs are of great interest.

Issues identified during call
- Clam aquaculture issues (UF professor) interconnected with NERR SWMP.
- Link with Coastal Storms Initiative (CSI) – NOAA/NWS – monitoring buoys
- Would love to get submerged habitat data, but not aware of a way to get it. Would like to map SAV and oyster bars, erosion around inlets, other dynamic areas.
- GTMNERR Site Profile needs to be conducted (via consultant) and GTMNERR Management Plan update coming up.

Existing Applications:

- Mapping, planning, illustrating – share data with local partners
- Identify research sites (use DOQQs)
- Working with N. Inlet/Winyah bay to develop ways of identifying potential sites for a certain type of crab
- Using to site weather station
- Land acquisition – mostly partners are taking the lead, but also used DOQQs to look at ownership and natural systems in order to prioritize areas

- SJR WMD generated land cover overlays – photo interpretation
- Maps in outreach, education, displays, handouts
- Basic mapping for research projects – a) monitoring project funded by USGS and SJR WMD – sampling with 5 year fisheries monitoring project, b) CICEET project looking at sources of bacteria in estuary.
- Hydrodynamic Flow Model of Estuary: animation simulation available; Bathymetry recently done for SJR WMD (contracted)

Partnerships

- Work very closely with the Water Management District – they provide the technical expertise on GIS, data, etc.
- Have two NOAA Graduate Research Fellowships (GRF) graduate students from UF working on projects with GIS. GeoPlan Center at UF provided an intern for a term.
- DEP, tax appraiser (shared DOQQs), Flagler county, state parks

Final suggestions/comments/potential solutions

Use NERR/NOAA funds to have consultant produce a detailed analysis and description of land use change around the GTM NERR. Product should interface with Site Profile needs and contain summaries and recommendations that would be useful in management decision making and translation into education programs. Options for a more detailed break down of estuarine habitat types or land cover types should be examined.

Hudson River Conference Call notes

Capacity needs/Problem issues:

Training
NERR staff not experts in GIS. Cornell fills most GIS needs
Benthic mapping also contracted out
Would like to train education coordinator, more of staff
Cornell will be training staff in GIS – refresher, spatial analyst

Technology/Data
- Define how to use benthic mapping data, and how to integrate into management
- Define benthic habitats and their functions – integrating groundtruth/sampling data with acoustic mapping
- Some of the water is too shallow to map using the current acoustic equipment setup
- Need to develop tools and protocols for change analysis, how often to monitor
- Challenges of managing the database, keeping information up to date
- How will these data be able to be accessed in future? Especially if not published, technologies change
- How to provide data to public in a user-friendly way
- Difficult to get aerial photos – weather, algal blooms

Priority issues:

Issues specified by NERR pre-call
- Investigate functions of aquatic habitats, determine what species are supported by these habitats
- Technology – developing shallow water survey techniques for vegetation and geophysical attributes
- Complete baseline survey data on community mapping, then look at change. How do human impacts affect management issues (boat scarring)? Esp. SAV beds

Other issues which could be addressed using RS
- Investigating ecological impacts of control methods for invasive species
- Investigate sediment transport – especially toxic substances that are transported with fine-grained sediments. Part of benthic mapping?
- Locate cultural resources – shipwrecks, etc. Benthic mapping
- Investigate historical oyster reefs – why does system no longer support oysters?
- Update oil spill response contingency plans, ESI maps

Existing Applications:

- SAV mapping and change over time. Drives the restoration science and habitat restoration plans. Lead for entire Hudson River estuary. Emphasizes the importance of the habitat
- Outreach and education – working with regulatory agencies, NGO's, and boaters to tell them about SAV issues and how to protect
- Advise permitting agencies – define critical habitats. Success story – one applicant did avoid SAV and proposed some planting to mitigate
- Investigate rate of expansion of invasive species (*Phragmites*)
- Benthic mapping using side scan sonar, multibeam bathymetry, bottom profiling, ground penetrating radar
- Provide info for natural resource damages claims, Hudson river cleanup efforts

Partnerships

- Cornell University – Institute for Resource Information Systems (IRIS)
- NY Sea Grant
- Institute of Ecosystems Studies
- USDA soil scientists, Scripps oceanographers (v. interested in benthic mapping)

Final suggestions/comments/potential solutions

- Important to have strong partnerships, with a sense of teamwork. Quarterly meetings, and define research and management priorities
- Important to bring in education and outreach from the beginning
- Good to have strong source of funding (high level of government support – in this case, Governor Petaki funded the "Hudson River Estuary Program" – real estate transfer tax funds environmental work
- Take a long-term ecological view.
- Homeland security issues and presence of historical resources (shipwrecks) may limit data distribution
- Student fellowships

Jacques Cousteau Conference Call notes

Capacity needs/Problem issues:

Training/Personnel
Have a full time GIS staff member. Do lots of RS, in conjunction with Rutgers CRS

Technology/Data
Have an education center with plenty of computers with ArcView, used for training, outreach, teacher programs
Bottleneck: Benthic habitat mapping

Priority issues:

Issues specified by NERR
- Benthic habitat mapping – use side scan sonar with REMUS (remote controlled torpedo-like device), may also do some multi-beam mapping. Difficulty is figuring out how to do the shallow areas
- Land use/land change – heads up digitizing to document change in watershed. Impervious surface, population change, amount of altered land, etc.
- Salt water marsh habitat – document the change since the marshes have been diked; compare diked and non-diked. Some restoration efforts have begun outside of the reserve area. Would like some elevation data to work on this project. Difficulty is in finding time to work on the project

Issues identified during call
- Investigate the potential of using RS to detect HAB (especially brown tides).
- Discussing how to link up the benthic sampling with GIS/RS efforts. Want to get as close to real-time info as possible

Existing Applications:

- Updating land use data set with SPOT and Landsat data. Using for build-out analysis of watershed, predict population increase and impervious surface area. In partnership with Rutgers' Center for Remote Sensing. Aimed at coastal decision makers, create interactive website.
- SAV study using aerial photography, NOAA classification scheme

Partnerships

- Center for Remote Sensing at Rutgers
- NJ DEP

Jobos Bay Conference Call notes

Capacity needs/Problem issues:

Training/Personnel
Bottleneck: Need someone to do the RS analysis. Training and staff time are a problem. Want to hire GIS specialist, but difficult to attract to the area

Technology/Data
Have plenty of hardware, software (ArcView 3.2 and 8.0, Spatial Analyst, GPS units)

Broader Management issues
Want to know what tools can assist with habitat degradation – identify applications to use for monitoring resources.

Priority issues:

Issues specified by NERR
- Land use effects on resource health and condition – monitor habitat change, update baseline layer and make it more specific, use a finer classification.
- Runoff and effect on water quality and resources – BASINS model (see existing apps)
- Groundwater demand and effects on estuarine health. Use model similar to that for impervious surfaces – correlate land use with demand and then impacts. Use in planning/permitting?

Existing Applications:

- Modeling watershed using BASINS – SWAT model (Transport, nutrients, soil). GIS application mainly, also using aerial photography to determine what crops are growing (part of model input). Involves detailed land use/vegetation GIS inventory
- Nitrogen transport model – GIS application – identify sources of nitrogen
- Black mangrove habitat assessment model in development. ArcView image processing
- Air quality modeling – GIS not RS. Land use would be used for analysis of impacts of air quality problems

Partnerships

- Contracting out image analysis work – habitat mapping
- EPA, University of Puerto Rico, DNR, CZM
- Good partnership with University of Puerto Rico (UPR) – students do GIS projects, give lots of resources

Kachemak Conference Call notes

Capacity needs/Problem issues:

Training/Personnel
Bottleneck: Funding for personnel. There is a 50% GIS person, but would like to have full time. Staff has basic ArcView training, but don't use it often enough.
Would probably contract out image analysis for land cover

Technology/Data
Want benthic/subtidal habitat, depth, and physical characteristics, land cover data
3-4 machines with ArcView, several people that know how to use it. Spatial Analyst, Image Warp.
Plan to transition to Arc8

Priority issues:

Issues specified by NERR
- Saltmarsh plant community classification. Reserve wants to look at elevation, including the effects of sea level rise on marsh communities.
- Eelgrass mapping, subtidal communities and physical habitat. Instrumentation is needed for this project – potentially acoustic sensors. First a rapid assessment is required, then maybe later a higher resolution map. Explore the linkages between physics and ecology.
- Freshwater wetland plant community classification. This is the extension of the wetlands function project to the freshwater community. More imagery is required. Reserve is already working with the AK Natural Heritage Foundation in a pilot area. Soil survey, botanical assessment. A different classification scheme will have to be developed.

Existing Applications:

- Using Ikonos and DOQQ's, reserve is doing a wetlands function assessment. Research looks at geomorphic land forms, surrounding use, slope, channelization, to provide a conceptual framework of the functionality. Can be used as an educational/planning tool for the community, including managers and property owners
- Intertidal habitat mapping, using aerial photography and videography
- USGS coastal erosion project. Using video cameras to take photos of surf zone, to develop a sand transport model. This is a way to look at the effects of mitigation
- Looking at SeaWiFS and AVHRR to estimate primary productivity and how it is transported into Kachemak Bay from the gulf.

Partnerships

- AK Natural Heritage Foundation
- Natural Resources Conservation Service
- EPA
- Community Rivers Planning Coalition (community group)
- Cook Inlet Keepers(environmental advocacy and water quality monitoring)
- USGS, AK Fish and Game, University of Alaska Fairbanks, Oregon State, NASA (algorithm development)
- City of Homer

Narragansett Bay Conference Call notes

Capacity needs/Problem issues:

Training/Personnel
RC is the GIS person on staff, maps and some analysis
Bottleneck: Staff training in RS (what is out there, and how can it be used?)

Technology/Data
Would like parcel data for land acquisition purposes
Using ArcView 3.2, would like ArcInfo

Broader Management issues
No RS done at reserve, but they get a lot of GIS data from the state and use it in projects

Priority issues:

Issues specified by NERR
- Want to look at change in land use over time. Increases in impervious surfaces, historic change, estimates of stormwater loading, timing of storm events, and the disappearance of eelgrass. The information could be brought to regulatory agencies and residents for stormwater policies.
- Look at water quality parameters: temperature change, including the effects of overall climate change, and effects on oxygen and nutrients, chlorophyll, etc. This could be part of a long term monitoring effort across the system.
- Invasive species identification, monitoring, look at the effects of burning

Existing Applications:

- Data Rescue – retrieving historic data and creating useable digital layers.
- State is developing land cover maps from aerial photographs.
- Several RS applications within the bay, though not necessarily in reserve boundaries:
  - Mapping seagrasses with aerial photography (University of Massachusetts Amherst and US FWS, contracted by Narr. NERR). Photographs were used in proposal to Coastal Program in RI, NERR seagrass beds are now all protected.
  - Landsat and aerial photos used to look at impacts of a power plant in Mt. Hope Bay. Conducted by Brown University with NERR and ASA, Inc.
- NEP is using aerial photos to look at five areas for historical land use change
- Identification of critical upland habitats
- Using aerial photography for prioritizing parcels for land acquisition
- Using GIS to show areas of vulnerability to oil spills; habitat data, finfish coverages, etc. These maps can help in permitting decisions

Partnerships

- URI and state provide a lot of GIS layers, could get Arc8 from them

North Carolina Conference Call notes

Capacity needs/Problem issues:

Training/Personnel
Bottleneck: Never enough staff
Full time GIS staff in Wilmington, occasional part time input, interns, etc.

Technology/Data
Need more benthic data – otherwise, have access to plenty of data layers. Want bathymetry, sediment classification, grass/oyster bed mapping, infauna mapping, temporal repetition.

Broader Management issues
Four different offices, personnel spread out

Priority issues:

Issues specified by NERR
- Delimitation of habitats for management plans, using aerial photography
- Invasive species management – determine if species is invasive or benign
- Shoreline deliniation for mapping and research/education

Issues identified during call
- Future: Tracking contaminants down the waterways, for shellfish closings, CTP, etc.

Existing Applications:

- Human dimension studies – documentation of change in Masonboro Island from visitor use
- Determination of exact trail locations – plotting GPS tracks on ortho photo quads
- SST for offshore work
- Integration of water quality information – developing a system to simultaneously collect depth and water quality data. Create contour maps with salinity, DO, etc.

Partnerships

- Parent agency – NC Department of Environment and Natural Resources, Division of Coastal Management
- Borrow imagery from NOAA lab

North Inlet/Winyah Bay Conference Call notes

Capacity needs/Problem issues:

Training/Personnel
Reserve is in the process of searching for an RC
Would like more staff or researcher with RS expertise. Currently can do analysis, but not so much project management

Technology/Data
Have plenty of hardware, software
Would like GPS unit
Primarily go to USC lab for GIS/RS work – don't need so much in-house capacity
Need: good elevation model

Priority issues:

Issues specified by NERR
- Habitat characterization and change (uplands, wetlands, benthic). Already using RS for shellfish mapping. Understand how changes in watershed impact the water quality.
- Shoreline change over time – erosion on barrier beach. How to mitigate erosion? Use RS data to help property owners understand the beach issues
- Impervious surface mapping and effect on water quality. Design good stormwater runoff plans.

Issues identified during call
- Baruch foundation concerned with monitoring *Phragmites*

Existing Applications:

- Impervious surface project in Murrell's inlet. Not in reserve boundaries yet, but interested in extending the project
- Use imagery for researchers – ID study sites, maps for presentations
- Outreach for Georgetown county – GIS for hazard mitigations, disaster preparations. Use parcel data, aerial photography
- Several research projects being done within reserve – USC geography student using ADAR, Ikonos, AVIRIS, to look at bi-directional reflectances
- CICEET funded project to do shellfish mapping using hyperspectral imagery and LIDAR
- Prioritize areas for acquisition using aerial photography
- CTP – workshop for data sharing, working with local counties to provide them with GIS resources
- Aerial photos/maps for education

Partnerships

- Debbiedew property owners
- Local government – Georgetown county disaster mitigation)
- Baruch Foundation (part of USC)
- Murrels Inlet 2007 group

Old Woman Creek Conference Call notes

Capacity needs/Problem issues:

Training/Personnel
Reserve staff does not have much experience with GIS, but would like to hire someone.
State government will not allow NERR to hire full-time personnel.
RC has had ArcView course, but doesn't have the time to actually do GIS.
The DNR has a GIS unit in Columbus, but it was hit with the budget crisis, so NERR now has to contract out GIS work.

Technology/Data
Would like to acquire high resolution imagery
ArcView 3.2 is on site, with Spatial Analyst. Several data layers (soil maps, political boundaries, 2' contour maps).

Priority issues:

Issues specified by NERR
- Use RS to document land use change. Old Woman creek is in an agricultural watershed, with increasing development and impervious surfaces.
- Characterization of agricultural practices, by no till, minimum till, etc. Look at the percent of the watershed that uses conservation practices.
- Near-shore and stream aquatic vegetation mapping within the watershed. Farmers and the township are becoming more interested in conservation. Assess the effects of stream setbacks, riparian zones, livestock management, and its affects on streams. Are BMP being followed?

Existing Applications:

- Photograph estuary each year to look at vegetation change, very variable with constantly changing lake levels. It is primarily emergent vegetation, but SAV has begun to appear.
- Aerial photography primarily used to draw researchers, or loaned to local governments for zoning purposes.

Partnerships

- There are no nearby universities to make partnerships with, but they have graduate fellowship
- State, county, and local governments. No NGO's

Padilla Bay Conference Call notes

Capacity needs/Problem issues:

Training/Personnel
Very important: Want to make sure to keep funding sources for GIS staffer– currently grant-writing to maintain position

Technology/Data
Want high resolution color aerial photography for mapping
ArcView not supported on Macintosh system
Image Analyst, 3-D Analyst to enhance analysis capabilities
Obtaining LIDAR data is priority, also color orthophotographs for baseline
Bottlenecks: Don't have current high resolution reference image for rectifying datasets. Need RS software (Erdas, ENVI, compression software)

Priority issues:

Issues specified by NERR
- Seagrass mapping: Track interannual changes in distribution and abundance of intertidal and subtidal eelgrasses. Potential use in permitting and regulatory process. Would prefer high resolution – 1:13,000
- Bathymetry of Padilla Bay, topography of watershed. Fine scale (cm) because little relief in NERR. May help in species differentiation, mapping of oyster beds. LIDAR
- Habitat mapping using orthophotos. These are needed as a baseline reference data layer, and would enable habitat mapping for baseline and to track changes

Issues identified during call
- What crops are grown in surrounding agricultural areas? Different amounts of suspended solids, pesticides, nutrients
- LU/LC in watershed, look at change. Want high resolution– 1 foot on mainland, 5 feet in intertidal zone
- Mapping and change detection for macroalgal mats. They provide an early indication of eutrophication and also kill eelgrass below them.
- Invasive species – track occurrence, spread, understand habitats they are found in.

Existing Applications:

- Mapping of eelgrass beds using aerial photographs. Used to assist researchers, document change
- Map winter cover crop, presence and condition. Used in demo farm for education of farmers

Partnerships

- Local Indian tribe
- Local GIS users group

Final suggestions/comments/potential solutions

Free extension – Image Warp – rectification of photographs

Rookery Bay Conference Call notes

Capacity needs/Problem issues:

Training/Personnel
Need more practice with ArcView, Spatial Analyst.
Bottleneck: Want to keep their GIS specialist trained well

Technology/Data
Difficult to get subtidal info – macroalgae blooms, turbidity
Can get hardware, but more difficult to get software. Not sure what is most appropriate.
Bottleneck: Want standardized protocol for classification

Priority issues:

Issues specified by NERR

- Land use coverage – pollution and flow way change. Need more specific categories – types of agriculture, golf courses using BMP, etc. Needs more than RS info. Include hazard assessment component. Use in outreach programs for people making decisions on land-use practices. Inform acquisition, permitting review, restoration plans, etc.
- Terrestrial habitat – vegetation coverage, linked to multispecies and fire management. Need baseline map, groundtruthing for fine detail. Need to find a way to ensure accuracy and repeatability
- Subtidal habitat – map bathymetry, look for seagrass beds, sediment types. Identify areas off-limits for planned clam aquaculture, look at changes resulting from freshwater inflow, incorporate fisheries sampling data with sediment types.

Existing Applications:

- Land use maps for management plans, writing proposals. General categories only
- Developing multi-species management plan; need more terrestrial, subtidal mapping
- How well are proscribed burns working?
- Watershed modeling and GIS to map flow ways. How much has development altered them? Where does the pollution go?
- University of South Florida doing sidescan sonar work in reserve, Canadian group working on other benthic issues
- With new learning center, will use GIS for education and outreach
- Mapping sea turtle nests - Conservancy of SW Florida – see if locations change relative to Australian pines, shoreline change

Partnerships

- SWFWMD (Southwest Florida Water Management District), USFWS (Big cypress Reserve and 10,000 Islands), tax appraiser for Collier county, Conservancy of SW FL

Sapelo Conference Call notes

Capacity needs/Problem issues:

Training/Personnel
Bottleneck: Lack of personnel.
Could use more training for current staff, also soon to hire stewardship coordinator

Technology/Data
Have Pathfinder 2.5.1, ArcView 3.2 (hesitant to move to Arc8)
Able to access university resources currently (including Image Analyst, Imagine), but once their current GIS specialist leaves, it may be more difficult.
Want higher resolution data (eg Quickbird or Ikonos)

Priority issues:

Issues specified by NERR
- Want series of photo coverages so can look at changes on mainland (high growth on mainland). Historic info on water quality from University of Georgia (UGA) Marine Insitute. Concerned with impacts to marsh from development. May use this to influence planning/policy at county level
- Marsh vegetation changes, as a result of sea level rise. Marsh is an edge community, therefore a good indicator. Policy implications.
- Assess natural resource management practices. Want to look at effects of controlled burns, timber harvests, efforts to increase wildlife forage, etc. Define land management uses with habitat maps, uses of land.

Issues identified during call
- Would like to do more with education and outreach – community-wide involvement
- Invasive species

Existing Applications:

- Long Term Ecological Research (LTER) project on water quality provides training for teachers (http://gce-lter.marsci.uga.edu/lter)

Partnerships

- UGA Marine Institue, marine science program, CZM program
- Info Tech Outreach (ITO) at the UGA – processing for GA GIS data clearinghouse

South Slough Conference Call notes

Capacity needs/Problem issues:

Training
Need GIS specialist. Hard to retain talented GIS folks
Tough to become specialized at GIS within the NERR, prefer to contract out the tougher analysis. Capable of producing maps but not analysis
Not familiar with RS tools

Technology/Data
- Need a tech/systems manager to keep system running smoothly
- Don't really know what data is available, how to use it.
- No existing LU/LC data sets
- Gaps in estuarine habitat understanding because Oregon commercial fisheries don't rely on estuary. Want more info on ways fish utilize habitats
- Want more info on anadramous fishes
- Want current 1 meter aerial photography data set, to pick up extreme patchiness (seagrass beds, fringing marsh, drainage channels, tributaries
- Gathering data on tidal currents, sediment movement

Broader Management issues
Build capacity with the county; neighboring county has no digitized info on land ownership, etc.

Priority issues:

Issues specified by NERR pre-call
- Developing maps for critical habitat. Specific spatial descriptions using high resolution images. Where are oyster beds, wildlife corridors, etc.
- Bathymetric and topographic map of estuary and adjacent lowlands
- Habitat and land use changes. Coos Bay has a large human population, would like to see LULC done for entire estuary

Other issues which could be addressed using RS
- Would like to become the source of info on water/sediment movement.
- Analyze management actions within and outside the NERR boundary. i.e. clearcut forest areas, creation of reservoir
- Acquisitions – prioritize future land buys
- Design of MPA's
- Aid in development of oil spill response model (work with ORR), modeling of emergencies such as tsunamis

Existing Applications:

- Restoration of diked/tidal wetlands
- Creation of maps for management plans, presentations, fundraising, educational tools
- Local watershed association used GIS for mapping county roadways, how bridges, culverts interact with watershed. Gleaning info for fish habitat restoration. Basis for prioritizing culvert replacement and sediment management
- LU/LC change

Partnerships

- County government, port authority, public lands managers, BLM, tribes, Army Corps – all developing GIS capacity and co-operating with one another.
- Local watershed association – utilized their GIS systems
- Corps is collecting LIDAR data to look at coastal hazards on beaches. May be able to persuade them to do more extensive flights.
- CZM partnership

Final suggestions/comments/potential solutions

Rather than GIS training, provide some sort of "help desk" for GIS issues
Share GIS position with other organization(s)

Tijuana River Conference Call notes

Capacity needs/Problem issues:

Training/Personnel
Had a part time GIS tech
Bottleneck: Training and staff, want 20 hr/week minimum staff member.

Technology/Data
Some ADAR data available through the Border Patrol, but not within reserve boundaries.
GIS computer was stolen in September
Would like fine resolution elevation data (LIDAR?) at a minimum before and after the rainy season, preferably after each major storm event (less than 10 per year)

Broader Management issues
GIS/RS not used yet in management

Priority issues:

Issues specified by NERR

- New roads and trails are being created by the border patrol. NERR wants to look at the historical data, using old aerial photography, to see how the roads developed. The Department of Immigration and Natural Resources (INS) intends to erect a large triple fence along the border, filling in mesas and arroyos in the process, which should cut down on their patrol in backcountry areas, but will increase fragmentation and sedimentation.
- Monitoring restoration and management sites – weed eradication areas, restored salt marsh geography. How do tidal creeks and vegetation of marshes change with sediment inputs?
- High sediment loads within the reserve. Most of the canyons in adjacent Mexico are bare or paved over, so the reserve experiences lots of sedimentation during the rainy season. This entails large sediment plumes, and the input of trash and debris. One management project is to build sediment catch basins, and RS may help in monitoring these efforts. This may entail elevation data, land cover (changes in vegetation will suggest changes in elevation).

Existing Applications:

- Habitat monitoring for fish and invertebrates. GIS used to assign classes to the channels, orthophoto quads used to classify vegetation
- Tidal restoration and looking at the impacts of tidal channels

Partnerships

- GIS and Remote Sensing program at San Diego State University, Pacific Estuarine Research Lab (PERL)
- University of California, San Diego, Scripps Institute

Waquoit Bay Conference Call notes

Capacity needs/Problem issues:

Training/Personnel
Have not worked with spatial modeling of RS images – need to find ways to USE data
Bottleneck: Innovative strategies for incorporating GIS and RS into education, management, and time for someone to work on these issues. GIS person very part time, will probably leave reserve soon. IT person full time w/many responsibilities

Technology/Data
Bottleneck: Do not have image processing software – ArcView with Spatial Analyst only
Do not have a plotter to create maps
Know lots about the aquatic areas, not so much about terrestrial
Some data still in paper format, needs to be put in digital
Need to upgrade computer w/ more memory, better internet capacity

Priority issues:

Issues specified by NERR
- Anthropogenic forcing of water quality parameters
    - Impervious surface detection, change over time. Modeling of nitrogen inputs and effect on estuary
- Monitoring coastal structures (docks, piers, revetments) and coastal change – see if you can see a link between these. Estimate erosion rates and change in these rates. Associations between coastal structures, socioeconomic factors
    - Establishing management plan for ACEC (Area of Critical Environmental Concern) for coastal structures
    - Monitor illegal dock building activity
- Habitat mapping – ID areas for acquisition, restoration, education. Want to do fine scale (better than 1:24,000 photography). 10m scale – potentially hyperspectral imagery?

Existing Applications:

- Education – adult ed, student programs, teacher development. Show ground water flow, land uses, development, etc.
- Change of coastline and landforms over time
- Display – create themes, maps, background images
- Legal issues: jurisdiction, historical connection of two ponds
- Management of invasive species: how are levels of *Phragmites* changing?
- Development of methodology of using hyperspectral photos to assess eutrophication
    - Very shallow. Want to look at effects of boats, prop trails, etc. Sediment classification scheme.

Partnerships

- MBL lab at Woods Hole Oceanographic Institute (WHOI)
- Work w/ partners on land acquisition to define undeveloped parcels, connectivity, habitat mapping
- US and State Fish and Wildlife Service
- Local Indian tribes
- Local towns
- Arenda Wildlife Trust
- Falmouth Rod and Gun Club

- Department of Environmental Management (DEM) (NERR is in DEM)
- Upper Cape Municipal GIS Users group – involves 6 towns, reps from Cape Cod Commission (regional planning body), WHOI. Trying to coordinate data collection; train users

Final suggestions/comments/potential solutions

Watershed is fairly small – 5K hectares – want to map entire watershed
Will probably contract w/Urban Harbors Institute @ UMass Boston
Not enough money to really have good GIS capacity, nor to hire consultant

Weeks Conference Call notes

Capacity needs/Problem issues:

Training/Personnel
Have full time GIS staff
Bottleneck: Training

Technology/Data
No image processing software
Want high temporal resolution, and land use/habitat data sets

Priority issues:

Issues specified by NERR
- Land use – impervious surfaces, sources of runoff, etc. Also look at change in land use, population growth
- Habitat change – look at impacts of exotic species. Include benthic habitats and throughout watershed.
- Analyze water quality – turbidity, eutrophication, algal blooms, submerged habitats, impacts of polluted runoff. Shoreline erosion/accretion

Issues identified during call
- Look at HAB events

Existing Applications:

- Use aerial photos to look at erosion, turbidity, habitat types, and development issues.
- Land acquisition/land use
- Identify ecotones, plan project locations, set up non-random transects
- Identify areas at high risk for erosion (based on land use, topography) - graduate research fellowship project

Partnerships

- State lands within Department of Conservation and Natural Resources
- MS Sea Grant
- NEP
- Auburn University – source of potential graduate students
- Potentially might partner with NASA Stennis to get RS data

Wells Conference Call notes

Capacity needs/Problem issues:

Technology/Data
Would like to have image analyst, increased capacity for spatial and image analysis
Would like to have more recent set of aerial photos
Data is currently in many different projections,
Bottleneck: Time, money, training. Want to invest in staff to do analysis in house

Priority issues:

Issues specified by NERR
- Landscape scale watershed management, especially along riparian zones. Restoration of wetlands, de-fragmentation
- Geomorphology of saltmarsh – high-resolution contour mapping – bathymetry and elevation. LIDAR would be great…how does elevation affect communities?
- Plant zonation and vegetative cover. In order to restore, must know what is there. Want a current LU/LC change analysis – contract out?

Issues identified during call
- Salt pan restoration – see if it is ecologically friendly. Will probably need aerial photography (satellite not enough detail)

Existing Applications:

- Shoreline project – define areas with potential development, impervious surfaces.
- Use aerial photos for conservation mapping. Assist land trust and conservation groups with GIS work (coverages, photos, etc). Used in grant writing, conservation planning. Work with 22 separate towns and conservation groups.
- Coastal habitats – map habitat features of fringing saltmarsh. Have a graduate intern assisting in this project.
- Use aerial photos for proposals, identify sampling sites, locate salt pans, public outreach, etc.

Partnerships

- Antioch university – sends graduate student interns
- Greater Mount Aga Conservation Initiative – state agencies working to identify conservation priorities. (vegetation mapping, protected areas acquisition) Reserve is pulling together data, facilitates meetings.
- Return the Tides (quasi-NGO)
- Gulf of ME Council on Marine Environment – reps from 3 states and 2 Canadian provinces
- FWS, NGO's, local government, southern ME regional planning body, CZM Program, Department of Marine Resources

Appendix C - NERRs Wetland/Habitat/Land Cover Data Summary

1) Ace Basin Reserve (South Carolina)
   a) 1989 and 1994 NWI Data, 1:24K (Source: ACE Basin CDROM)
   b) 1990 and 1995 land cover data (CCAP and Raw TM), 30 meter pixels (Source: ACE Basin CDROM)

2) Apalachicola Reserve (Florida)
   a) CSC and NERR developed Benthic Habitat Maps (Source**:** http://www.csc.noaa.gov/lcr/text/nerrlink.html)
   b) National Wetlands Inventory (Source: http://www.dep.state.fl.us/gis/datadir.htm)
   c) Land Use 1995 and 1998 (Source: http://www.dep.state.fl.us/gis/datadir.htm)

3) Chesapeake Bay Reserve-MD (Maryland)
   a) Bathymetry data for Chesapeake Bay (Source: ftp://ftp.chesapeakebay.net/pub/Geographic/ChesapeakeBay/)
   b) CSC land cover change data. Land cover for 1984 and 1988/89. Landsat TM-30m pixels. (Source: http://www.csc.noaa.gov/crs/lca/chesa.html)
   c) National Wetlands Inventory data – still need to determine appropriate spatial extent (http://wetlands.fws.gov/downloads.htm).

4) Chesapeake Bay Reserve-VA (Virginia)
   a) Comprehensive Coastal Inventory Program (CCI) (http://www.vims.edu/ccrm/gis/gisdata.html)
   b) CCI Tidal Marsh Inventory (Source: http://www.vims.edu/ccrm/gis/tmi.html)
   c) CCI Virginia Coastal Resources Management Program, land cover for 1997 (Source: http://www.vims.edu/ccrm/gis/lc1534.htm)
   d) CSC land cover, 1984 and 1988/89. Landsat TM-30m pixels. (Source: http://www.csc.noaa.gov/crs/lca/chesa.html)
   e) National Wetlands Inventory data – still need to determine appropriate spatial extent (http://wetlands.fws.gov/downloads.htm).
   f) Bathymetry – same data as Ches. Bay, MD (Source: ftp://ftp.chesapeakebay.net/pub/Geographic/ChesapeakeBay/)

5) Delaware Reserve (Delaware)
   a) Delaware Geological Survey, DEMs, DOQs (Source: http://www.udel.edu/dgs/dgsdata/degis.html)
   b) Delaware Office of State Planning Coordination, 1997 land use/land cover (Source: http://www.state.de.us/planning/info/lulcdata/lulc.htm)
   c) University of Delaware, Spatial Analysis Lab. Orthophotos (1992, 97); land use/land cover 1984 (Landsat MSS 79m pixels), 1992 and 97 (1m digital orthophotos); DEMs. (Source: http://www.udel.edu/FREC/spatlab/)

6) Elkhorn Slough Reserve (California)
   a) CaSIL – watersheds, groundwater basins, hydrography, wetlands (SF Bay/Delta only), vegetation (small scale, not from imagery). (Source: http://www.gis.ca.gov/data_index.epl)
   b) National Wetlands Inventory data – still need to determine appropriate spatial extent. (Source: http://wetlands.fws.gov/downloads.htm).

7) Guana Tolomato Matanzas Reserve (Florida)
   a) Florida Department of Environmental Protection - Bathymetry, National Wetlands Inventory data, select land cover (South Florida). (Source: http://www.dep.state.fl.us/gis/datadir.asp)
   b) GIS Export Library-data for the St. Johns River area/management district. Digital orthophotos-2000 at 1m, 3m, and 6m; Land use/land cover- 1973/90/95; National Wetlands Inventory, wetlands and deepwater habitat, wetlands vegetation; other useful data. (Source: http://sjrwmd.com/programs/plan_monitor/gis/docs/themes.html).

8) Grand Bay Reserve (Mississippi)
   a) Statewide data – site has much data, but doesn't have land cover, habitat, or bathymetry data. Site could be useful. (Source: http://www.maris.state.ms.us/statewide.html)

9) Great Bay Reserve (New Hampshire)
   a) GRANIT – Land use, land cover (1995, 2001), National Wetlands Inventory, and bathymetry. (Source: http://www.granit.sr.unh.edu/cgi-bin/load_file?PATH=/data/datacat/funclist.html)
   b) CSC land cover change – 1986 and1993, Landsat TM-30m pixels. (Source: http://www.csc.noaa.gov/crs/lca/g_bay.html)

10) Hudson River Reserve (New York)
   a) CSC and NERR benthic habitat mapping. (Source: http://www.csc.noaa.gov/lcr/text/nerrlink.html#Hudson)

11) Jacques Cousteau Reserve (New Jersey)
   a) NJDEP – Wetlands data 1986, Land use/land cover 1986, 95, 97. (Source: http://www.state.nj.us/dep/gis/)
   b) CSC Southern New Jersey land cover, 1994/95. (Source: http://www.csc.noaa.gov/crs/lca/s_jersy.html)
   c) National Wetlands Inventory Data – still need to determine appropriate spatial extent. (Source: http://wetlands.fws.gov/downloads.htm).

12) Jobos Bay Reserve (Puerto Rico)
   a) CSC NERR data rescue – land use/land cover for 1995; other ecological/habitat data. (Source: http://www.csc.noaa.gov/pagis/html/esdim/jobos.html).
   b) National Wetlands Inventory data – still need to determine appropriate spatial extent. (Source: http://wetlands.fws.gov/downloads.htm).

13) Kachemak Bay Reserve (Alaska)
   a) Bathymetry, 10m interval. (Source: http://www.csc.noaa.gov/lcr/kachemak/html/imgatlas/iaphys.htm).
   b) 1989 Land cover, Landsat TM 30m pixels. (Source: http://www.csc.noaa.gov/lcr/kachemak/html/imgatlas/iabio.htm#Habitats)
   c) National Wetlands Inventory, Kenai and Seldovia quadrangles. (Source: http://www.csc.noaa.gov/lcr/kachemak/html/imgatlas/iabio.htm#Habitats).

14) Narragansett Bay Reserve (Rhode Island)
   a) CSC land cover data, 1991/97, Landsat TM 30m pixels. (Source: http://www.csc.noaa.gov/crs/lca/mass.html).
   b) A wide variety of habitat data from CSC NERR data rescue. (Source: http://www.csc.noaa.gov/pagis/html/esdim/narr.html).
   c) Wetlands, bathymetry, water classification, land use 1988/95, ecological data from RIGIS. (Source: http://www.edc.uri.edu/rigis-spf/statewide/state.html).

15) North Carolina Reserve
   a) CSC land cover, 1991/97 Landsat TM 30m pixels. (Source: http://www.csc.noaa.gov/crs/lca/n_car.html)
   b) 1996 land cover from North Carolina Corporate Geographic Database (CGDB). Landsat TM 30m pixels. (Source: http://www.cgia.state.nc.us/cgdb/catalog.html).
   c) 1987 land use/land cover – TM (Albemarle-Pamlico Estuarine Study area and eastern N Carolina). (Source: http://www.cgia.state.nc.us/cgdb/catalog.html)
   d) National Wetlands Inventory. (Source: http://www.cgia.state.nc.us/cgdb/catalog.html)
   e) Habitat Data – shellfish strata, significant aquatic endangered species habitats, and other data. (Source: http://www.cgia.state.nc.us/cgdb/catalog.html)
   f) Mapping application for some of the above data, from NC DNR, http://gis.enr.state.nc.us/DataCatalog/default.asp

16) North Inlet/Winyah Bay Reserve (South Carolina)
   a) CSC land cover for 1990/95, Landsat TM 30m pixels. (Source: http://www.csc.noaa.gov/crs/lca/s_car.html)
   b) Wetlands data from SC DNR, quad level data. (Source: http://www.dnr.state.sc.us/gisdata/index.html)
   c) LIDAR data, aerial photos, land cover, etc. from CSC's "South Carolina's Coast: A Remote Sensing Perspective" CD.

17) Old Woman Creek Reserve (Ohio, Huron and Erie Counties)
   a) Ohio DNR land use/land cover for various dates: 1994 land cover for both counties, 1981 land use/land cover for Huron County. (Source: http://www.dnr.state.oh.us/gims/response.asp?county=Select&category=LandUse%2FlandCover)
   b) Ohio DNR Wetlands Inventory, 1987 Landsat TM 30m pixel data. (Source: http://www.dnr.state.oh.us/gims/response.asp?county=ERIE&category=Hydrologic&Submit1=SELECT and http://www.dnr.state.oh.us/gims/response.asp?county=HURON&category=Hydrologic&Submit1=SELECT)

18) Padilla Bay Reserve (Washington)
   a) CSC NERR data rescue – Land use/land cover derived from aerial photos, bathymetry, wetlands, ecological data. (Source: http://www.csc.noaa.gov/pagis/html/esdim/padilla.html)
   b) Washington Natural Heritage Program GIS, rare plant species populations and endangered ecosystems. (Source: http://www.wa.gov/dnr/htdocs/fr/nhp/refdesk/gis/index.htm)
   c) Washington DFW, fish and wildlife maps upon request. (Source: http://www.wa.gov/wdfw/hab/release.htm)

19) Rookery Bay Reserve (Florida)
   a) Florida Fish and Wildlife Conservation Commission, FMRI, Rookery Bay NERR Water Quality Monitoring. (Source: http://als.dms.state.fl.us/~fdd/)
   b) Florida DEP – bathymetry, National Wetlands Inventory data, wetlands, selected land use-SWFWMD, SJRWMD? (Source: http://www.dep.state.fl.us/gis/datadir.asp)
   c) Misc. data, FL Geographic Data Library, mapping application. (Source: http://map.fgdl.org/download/)

20) Sapelo Island Reserve (Georgia, McIntosh County)
   a) Winter 1988/90 land cover for McIntosh County, Landsat TM 30m pixels. (Source: http://gis1.state.ga.us/search.asp?uId=clear6071&county=McIntosh&location=County&keyword=&startdate=1975&enddate=2002)
   b) Multi-Resolution Land Characteristics, 1996. (Source: same as above)
   c) USGS Level-I and Level-II land use/land cover for 1975, GA DNR land cover classification for 1992. (Source: http://csat.gatech.edu/statewide/downloads.html)
   d) CSC Land cover, 1992/97 Landsat TM 30m pixels. (Source: http://www.csc.noaa.gov/crs/lca/georgia.html)

21) South Slough Reserve (Oregon)
   a) Limited data from Oregon's Dynamic Estuary Manag. Info. Sys. (DEMIS). Environmental quality data, land use and planning. (Source: http://buccaneer.geo.orst.edu/data/demis_data.html)
   b) Can get NWI data at : : http://wetlands.fws.gov/downloads.htm

22) Tijuana River Reserve (California)
   a) National Wetlands Inventory data - still need to determine appropriate spatial extent. (Source: http://wetlands.fws.gov/downloads.htm).
   b) The Tijuana River Watershed Project – need to contact for data: land use, vegetation, hydrography, etc. (Source: http://typhoon.sdsu.edu/TJWATER/)

23) Waquoit Bay Reserve (Massachusetts)
   a) Orthophotos, land use 1999 (2002 update), orthophoto wetlands and streams, National Wetlands Inventory, bathymetry, environmental monitoring,and ecological data available. (Source: http://www.state.ma.us/mgis/laylist.htm)

24) Weeks Bay Reserve (Alabama)
   a) NWI data at: http://wetlands.fws.gov/downloads.htm

25) Wells Reserve (Maine)
   a) CSC land cover for Southern Maine, 1986/93 Landsat TM 30m pixels. (Source: http://www.csc.noaa.gov/crs/lca/maine.html)
   b) Maine GIS Data Catalog, Bathymetry, National Wetlands Inventory, wetlands data. (Source : http://musashi.ogis.state.me.us/catalog/catalog.asp)
   c) CSC Benthic Habitat Mapping in the NERRs. (Source: http://www.csc.noaa.gov/lcr/text/nerrlink.html#Wells)